

Fourth Contribution to the Marine Fauna of the Miocene Period of the United States.

By *E. D. Cope.*

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The three preceding "Contributions" appeared in the *Proceedings of the Academy of Natural Sciences of Philadelphia* for the years 1867, 1868 and 1869 respectively. Their subject matter is almost exclusively confined to the description of the remains of Cetacea which occur in the marine deposits of middle Neocene age of the Atlantic coastal region, and more exactly, in the Yorktown formation of Dana, or the Chesapeake formation of Darton and Dall. The present paper continues the description of these forms preliminary to an illustrated memoir on the subject. The word "marine" has been introduced into the title to distinguish the series from the numerous papers which have appeared on the paleontology of the lacustrine neocenes of the West. For the sake of uniformity the term Miocene is retained.

PHYSETERIDÆ.

PARACETUS MEDIATLANTICUS, sp. nov.

The genus *Paracetus* has been recently proposed by Lydekker* to include members of this family which possess a well-developed series of teeth in the (?) premaxillary and maxillary bones. It is up to the present time represented by one species, the *Paracetus pouchetii* Moreno, of the Santa Cruz bed of eastern Patagonia, of the district of Chubut. The present species is apparently not distantly related to that one.

This genus stands near to *Cogia* GRAY, and can scarcely, with present information, be referred to a distinct family. The presence of superior teeth cannot alone be regarded as necessitating this course, as they occasionally occur in *Cogia*. Thus in *C. sima* Owen, from the coast of India, there are two teeth at the anterior extremity of the upper jaw, and a male of a rather small species preserved in the U. S. National Museum from the eastern coast of the United States exhibits the same character.† A male in the Museum of the Wistar Institute of the University of Pennsylvania‡ from the coast of New Jersey at Sea Isle City, has no teeth in the upper jaw. The genus *Paracetus* seems to me to be only distinguishable from *Cogia* by the posterior extension of the tooth series to the posterior

* *Anales del Museo de la Plata: Paleontologia Argentina*; II: *Cetacean Skulls from Patagonia*, p. 8, Plate iii.

† For the opportunity of examining this specimen I am indebted to Dr. Goode, Director of the Museum.

‡ My thanks are due to Prof. Horace Jayne, Director of the Wistar Institute, for the opportunity of studying this specimen.

part of the maxillary bone. Perhaps when the skeleton is known other characters will be detected.

The name of this genus is stated by Dr. Lydekker in the text of his description to be as I have cited, but the name *Hypocetus* stands at the top of the paragraph in which this statement is made, and is also attached to the plate in which it is figured. I have followed Dr. Lydekker's expressed intention rather than what may be a *lapsus calami* or other mistake.

Char. specif—As the posterior border of the skull and the extremity of the muzzle of the specimen are broken off, an exact idea of its outline cannot be given. However, the form was probably much as in the *P. pouchetii*, and more elongate than in the species of *Cogia*. This form is subtriangular, with the basal border convex, and the two lateral ones slightly concave. The muzzle is probably, however, produced into a rostrum, as the maxillary borders are parallel at the point where it is broken off. On the right side, where the maxillary bone is best preserved, there are eight alveoli; the teeth are lost. The lateral border of the maxillary bone overhangs the tooth line considerably in front, and spreads away from it outwards and backwards in a gradually thinner edge to the deep notch which bounds the supraorbital region anteriorly. The rise of the anterior border of the facial basin is within this notch, and not without it, as in the species of *Cogia*; and is gradual, attaining a considerable elevation immediately in front of the temporal fossa, and a little within the vertical plane of the supraorbital border. The premaxillary bones are separated by the deep vomerine channel which they partially overroof on each side, and are separated posteriorly by the prenasal part of the vomer posteriorly. The latter forms an elevated crest directed forwards and unsymmetrically to the right. The premaxillaries spread gradually outwards posteriorly to a thin margin, and are concave opposite to the vomerine crest which separates them, that of the left hand descending to the narial orifice. The skull is broken off at the blow-holes, so that it is difficult to affirm positively whether the right blow-hole existed or not. It was apparently present, but smaller and posterior in position to the right one. The inferior surface of the maxillaries slopes upwards and outwards, leaving the inferior face of the vomer quite prominent below. The vomer forms the half of a circle in transverse section above, and extends as far anteriorly as the specimen extends.

There is a large supraorbital foramen between the preorbital notch and the rising edge of the facial crest, as in the sperm whale; and there is a smaller one in a direct line posterior to it just exterior to a more elevated part of the crest, within a line above the posterior part of the supraorbital border. A longitudinal groove anterior to the supraorbital foramen is pierced in its fundus by two foramina. Anterior to the groove a depressed foramen pierces the maxillary bone near the premaxillary border. Anterior and interior to the corresponding foramen of the left side a depressed foramen pierces the premaxillary bone. This foramen is absent from

the right side. In the other hand the right premaxillary is pierced near the anterior part of the vomerine crest by a large round foramen, which is wanting from the left side. A large foramen pierces the inner side of the lateral crest half-way to the superior border, and opposite the middle of the left blow-hole.

The dental alveoli are subround, and are separated by narrow septa. They are not deep, the deepest equaling 50 mm., so that the teeth have been easily lost.

Measurements.

	M.
Length of fragment on middle line.....	.800
Width of skull at supraorbital notch ; left side restored....	.800
Width of muzzle where broken off.....	.172
Width of right premaxillary at middle of length.....	.100
Width of left premaxillary at middle of length.....	.150
Width of right premaxillary at vomerine keel.....	.100
Width of left premaxillary at vomerine keel.....	.170
Elevation of lateral crest above orbit (apex broken off)....	.310
Length of series of eight teeth.....	.165

From Drum Point, Chesapeake Bay, Maryland.

CHONEZIPHIIDÆ.

Ziphiina Flower ; *Ziphiidæ* Gill (*Ziphius* preoccupied).

PELYCORHAMPHUS PERTORTUS, gen. et sp. nov.

Char. gen.—Allied to *Choneziphius*, but the solid rostrum of the vomer bifurcates posteriorly and embraces a basin which takes the place of the maxillary basin of the right side, and reduces that of the left side to very small dimensions. Blow-holes very unsymmetrical, the left only preserved in the specimen.

This genus has certain characters which ally it to the *Physeteridæ*. The internareal part of the vomer is directed very obliquely upwards to the left, and then forwards to the left on the superior surface for a distance, when it turns to the right as in *Paracetus* and *Cogia*. Instead of terminating at this point as in those genera, it assumes the swollen form and dense structure seen in the species of *Choneziphius*, and besides sending forwards the usual rostrum on the median line, it continues to the right, and apparently spreads out into a thin plate which forms the floor of a wide basin, and which apparently continues to and forms its right border, overlying the posterior plate of the maxillary. This basin is represented in *Paracetus mediatlanticus* by a longitudinal shallow concavity of the right side of the superior keel of the vomer, which is a rudiment as compared with the basin in the present genus. The rostrum of the vomer extends to the narrow extremity of the specimen, where it is broken off. The fracture exhibits no tube or channel.

It would not be surprising if this genus should prove to be related to *Anoplonassa* Cope, which has the long symphysis mandibuli of the *Physeter*, with the nearly edentulous character of the *Choneziphiidæ*.

Char. specif.—The species is founded on a rostrum similar in its mode of preservation to *Ziphioids* in general. Nothing is preserved posterior to the nares, and the edge of the left maxillary, with the end of the muzzle, is broken off. All the parts are coössified.

The anteroposterior diameter of the basin exceeds by a little the transverse. The bottom is nearly regularly concave, with a few shallow fossæ at the right side. The part of the median vomerine ridge which forms the anterior half of the left border of the basin is thicker than that which bounds the posterior half of the same, and it presents an angular tuberosity horizontally to the left. The fractured edge of the left maxillary shows that it was thin at this point, and at no point had it when perfect any considerable horizontal extension to the left side. It is separated from the vomerine ridge by a groove, which extends from the left maxillary basin to a foramen, which is situated at a point in advance of the greatest width of the vomerine rostrum. A corresponding foramen exists on the right side, which is opposite the anterior border of the central basin. The vomerine rostrum contracts rapidly forwards, forming a prominent rounded ridge, and the premaxillaries rise to it on each side. The maxillaries are little expanded, and their superior surface is subhorizontal and is moderately rugose. It is much thicker on the right side than on the left, and is probably also wider on the right side. On the left side it is bounded below by a deep groove from opposite the anterior part of the left maxillary basin to a point in front of and below the supramaxillary foramen of the same side already described. On the right side there is a similar foramen which bears the same relation to the supramaxillary foramen of the same side. In front of the foramen on the left side the groove continues. On the right side the groove does not continue, but is succeeded forwards by a narrow vertical wall to the anterior extremity of the specimen.

On the inferior side the middle line is deeply grooved to a point opposite the middle of the superior median basin. On each side of the groove the palatal aspect of the maxillary slopes slightly upwards, and on the left side rolls up to a thickened inferior border of the inferior or submaxillary groove. On the right side the palatal face of the maxillary turns up more obliquely to the border of the superior median basin.

Measurements.

	MM.
Total length of specimen.....	330
Length from front of median basin.....	150
Inside diameters of median basin..	{ anteroposterior..... 160 transverse..... 130
Depth of basin.....		64
Width of rostrum in front of basin.....	80

<i>Measurements.</i>	MM.
Width of rostrum at end of specimen.....	35
Width of lateral edge of right maxillary at inferior maxillary foramen.....	25
Length of inferior keel of vomer.....	120

This species exhibits the most unsymmetrical cetacean cranium known to me. Its size was probably about that of the *Choneziphius indicus* of the present ocean. Its exact locality is unknown, but it probably was exposed to the action of water for a considerable time, after being washed from its position of deposit. It has been bored by *Pholades* in several places.

BALÆNIDÆ.

I have remarked that the Mysticete with its single family the Balænidæ* "would seem to have derived their descent from some form allied to the Squalodontidæ, since their nasal bones are more elongated than those of the Odontoceti, and in *Plesiocetus*" (*Cetotherium*) "the superior cranial bones show some of the elongation of that family." This elongation of the superior cranial wall is not seen in the genus *Squalodon*, but is moderately developed in the genus *Prosqualodon* of Lydekker, founded on the *P. australis* Lydd. (*l. c.*) from Patagonia. It is exhibited in a still more marked degree by the genus *Agorophius* g. n. Cope, which is represented by the *Zeuglodon pygmæus* of Müller, which was referred to *Squalodon* by Leidy.† The form of the skull in this genus approaches distinctly that of *Cetotherium* of the Balænidæ, and the permanent loss of the teeth would probably render it necessary to refer it to the *Mystacocete*.

Stages of transition from some such genus as *Agorophius* to the typical whalebone whales are represented by several genera from the Yorktown beds. Theoretically the loss of teeth *by failure to develop* would be accompanied by the loss of the interalveolar walls, leaving the dental groove continuous and separate from the dental canal. A genus displaying these characters has not been discovered, but I have no doubt that it will be. The new genus *Siphonocetus* Cope exhibits the groove roofed over by ossification of the gum, and distinct from the dental canal. The genus *Ulias* indicates that a still farther degeneracy took place, in the fusion of the dental groove and dental canal, while the groove remained open. In *Tretulias* the same condition persists with the addition that the gingival passages and foramina are present, as in the genus *Siphonocetus*, and in

* "On the Cetacea," *American Naturalist*, 1890, p. 611; Meyer, *Studien über Säugethiere*, Jena, 1886, p. 191.

† *Extinct Mamm. Dakota and Nebraska*, 1869, p. 420, Pl. xix, Fig. 8. It is doubtful whether this genus should be referred to the *Zeuglodontidæ* or the *Squalodontidæ*. The relations of the maxillary and premaxillary bones posteriorly resemble most those of the latter family. It differs from *Prosqualodon* in the contact of the temporal fossæ on the middle line above, and in the greater elongation of the frontal and probably nasal bones.

the later genera. In *Cetotherium* and in later *Balænidæ* the groove and canal are fused, the gingival roof is complete, and it is perforated. It would appear, then, that *Ulias* may be descended from the undiscovered genus above mentioned, while *Tretulias* is descended from *Siphonocetus*. The exclusively Neocene genera may be tabulated as follows :

I. Alveolar groove and dental canal distinct.

Alveolar groove open.....Not discovered.
Alveolar groove roofed over and perforate.....*Siphonocetus* Cope.

II. Alveolar groove and dental groove confluent in a gingivodental canal.

Gingivodental canal open ; no gingival canals.....*Ulias* Cope.
Canal open ; gingival canals at one side.....*Tretulias* Cope.
Canal with complete and perforate roof..... *Cetotherium* Brandt.

SIPHONOCETUS PRISCUS Leidy, gen. nov. *Balæna prisca* Leidy, *Proceeds. Academy Philada.*, 1854, p. 308. *Eschrichtius priscus* Leidy, Cope, *Proceeds. Acad. Philada.*, 1869, 11. Leidy, *Extinct Mamm. Dakota and Nebraska*, 1869, p. 441. *Infra* Plate vi, Fig. 3.

Specimen in Museum of Academy of Natural Sciences of Philadelphia.

SIPHONOCETUS EXPANSUS Cope. *Eschrichtius expansus* Cope, *Proceeds. Acad. Philada.*, 1869, p. 11.

The two mandibular rami ascribed to this species are the property of the Maryland Academy of Sciences. The collection of Johns Hopkins University contains a fragment of a ramus of an individual of rather smaller size than the types. Plate vi, Fig. 5.

SIPHONOCETUS CLARKIANUS Cope, sp. nov. Plate vi, Fig. 4.

In the collection of the Johns Hopkins University there are portions of mandibular rami of two species of *Siphonocetus*. The cranium of this genus is unknown, but it is probably similar in character to that of the *Cetotherium* of Brandt. This genus differs from *Balænoptera* in having the elements between the supraoccipital and the nasals much elongated, so that there is a sagittal crest of greater or less length, and in the non-union of the dia- and parapophyses into a vertebral canal,* in which it agrees with *Eschrichtius* of Gray. Some of the rami described belong possibly to species of *Balænoptera*, and it remains for future discoveries to ascertain which these are.

One of the species above referred to is the *Siphonocetus expansus* Cope.† The other species differs from all of those known to me. In dimensions it exceeds those of any of the species described in this paper, and is only exceeded by the species which I have described (*l. c.*) under the names

* See *American Naturalist*, 1890, p. 611, where these genera are characterized; but Van Beneden's name, *Plesiocetus*, is used for *Cetotherium*, and the latter name for *Eschrichtius* of Gray.

† *Proceeds. Academy Philada.*, 1869, p. 11.

of *Cetotherium leptocentrum* and *C. cephalus*. It compares more closely in dimensions with the *C. polyporum* from the Chesapeake formation of North Carolina. From the last named, and from the *C. cephalus*, it differs in the robust form of the ramus, resembling in this respect rather such species as *C. paleatlanticum*, *S. priscus* (Leidy), and *S. expansus*.

The fragment representing the *S. clarkianus* is from the part of the ramus anterior to the base of the coronoid process, and is about 350 mm. in length. Both faces are convex, but the external is more strongly so than the internal. The superior part of the latter is, however, not horizontal as in the *S. priscus*, nor is the internal face subhorizontal as in *S. expansus*. The two faces unite above at an obtuse angle, which if perfect, would be nearly right. The inferior edge is on the contrary a ridge which would be acute were it not rounded. The section of the ramus is therefore lenticular, with one side more convex than the other. Posteriorly the external convexity becomes greater, and the internal convexity rises towards the base of the coronoid, leaving a gentle concavity above the inferior border. The external foramina are large, distant, and only a little further below the superior ridge than those of the inferior internal row. The latter are in two series; those of the superior smaller and quite near the superior edge; the others larger and situated lower down, and separated by intervals of about 40 mm. No trace of Meckelian or alveolar grooves.

Measurements.

		MM.
Diameters at distal end...	{	vertical..... 95
	{	transverse..... 72
Diameters near coronoid..	{	vertical..... 114
	{	transverse..... 99

The presence of two internal series of foramina distinguishes this species from any of those known to me. The rami are less compressed than those of the *C. pusillum*, while the external position of the external foramina distinguishes it from the *S. priscus* (Leidy). The presence of an acute-angled ridge below distinguishes it strongly from the *C. paleatlanticum*. The species was larger than the *Cetotherium megalophysum* above described, having probably attained a length of forty feet.

I have dedicated it to Prof. William B. Clark, of the Department of Geology and Paleontology of the Johns Hopkins University, to whom I am under obligations for the opportunity of studying most of the material here described. The label attached to the specimen states that it was dredged up near Point-no-Point, Chesapeake Bay, and was presented to Johns Hopkins University by Conrad Miller.

ULIAS MORATUS, gen. et sp. nov. Plate vi, Fig. 1.

Char. gen.—Mandible with the gingivodental canal open throughout most of its length, closed only near its apex. Gingival foramina represented by a few orifices on the alveolar border near the distal extremity.

This form is of much interest as representing in adult life a stage which is transitional in typical Balænidæ. The alveolar groove is continuous with the dental canal, and is permanently open. It is probable then that this genus possessed teeth during a longer period than the existing Balænidæ, and that they were retained in place by a gum so long that the canal could not close as is the case in the latter. The absence of the long series of mental foramina characteristic of the true whales is further evidence to this effect.

Van Beneden, in his *Descriptions des Ossemens Fossiles des Environs d'Anvers*, describes a Balænid under the name of *Balænula balænopsis* which is represented by numerous individuals. I agree with Lydekker (*Catalogue of Fossil Mammalia in the British Museum*, Vol. v) that Van Beneden has not given sufficient reason for separating the species generically from Balæna. There is also considerable diversity between individuals referred to the species. In a small specimen, a narrow alveolar groove is present, but Van Beneden makes no reference to the character in his description. As the groove is closed in large specimens figured, it is possible that M. Van Beneden regarded the character as one of immaturity. This may be the case, as the groove figured by Van Beneden is a very narrow one, and is quite different from the widely gaping channel in the *Ulias moratus*, which is founded on an adult animal.

Char. specif.—This species is founded on a nearly entire right mandibular ramus. The condyle and angle are wanting, as is also a piece from the proximal part of the distal third of the length. This piece was found with the rest of the specimen, but has been, for the present at least, mislaid.

The ramus is moderately curved horizontally, but is not decurved except towards the angle. A slight convexity of the inferior margin exists at the anterior part of the proximal two-fifths of the length. The superior border is occupied with the widely open alveolar groove, which gradually contracts in transverse diameter distally, so as to be closed for the terminal fourth of the length. On this region two or three large foramina issue from it on the middle line above, and the terminal mental foramen issues at the superior extremity of the distal end, a little below the internal ridge on the external side of it. Of the borders of the alveolar groove the internal is much lower than the external on the proximal sixth of the length. The edges are then equal for a short distance, and are acute. The internal then becomes the more elevated, and continues so until its point of union with the external. The internal wall of the groove is at first narrow, and its superior edge from being acute becomes narrowly rounded, but becomes more obtuse distally as the wall becomes thicker. The internal side of the ramus is very little convex. The external side of the ramus is strongly convex in vertical section, hence it is that the external edge of the groove becomes wider as it becomes lower, until at the beginning of the distal third of the length it forms a plane distinct from the convex external face. This external convexity growing rapidly less, the

superior edge becomes proportionally narrower, and at the extremity of the ramus is about as wide as the internal superior ridge. The extremity of the ramus is, in profile, truncated obliquely backwards and downwards to the obtuse angle at which it meets the slight rise in the outline of the inferior margin. The external plane is slightly concave. The internal face exhibits two surfaces, a superior convex portion which widens downwards and backwards, and an inferior wider flat portion separated from the superior by a straight ledge. The inferior border of the ramus is represented by an angle of about 70° for the greater part of the length. Below the region where the alveolar borders are equal the angle is more nearly right owing to the increased convexity of the external face. It is rounded below the coronoid process (which is broken off) and widens towards the angle. It is rounded on the distal third, becoming narrower rapidly towards the distal extremity.

Measurements.

	M.
Length of ramus restored ; on curve.....	1.900
Length of proximal fragment.....	.790
Length of distal fragment.....	.390
Transverse diameter near condyle.....	.070
Transverse diameter where alveolar borders are equal.....	.060
Transverse diameter at distal end of long fragment.....	.057
Vertical diameter where alveolar edges are equal.....	.073
Vertical diameter at distal end of long fragment.....	.074
Vertical diameter at proximal end of distal fragment.....	.079
Transverse diameter at proximal end of distal fragment...	.049
Vertical diameter of extremity.....	.065

Besides the generic characters, the *Ulias moratus* presents various specific differences from the various species of *Balænidæ* which are known. The flatness of the internal face and the lack of decurvature distinguishes it from several of them ; and the absence of fissure at the distal mental foramen separates it from others. I know of no species which has only one series of foramina and that one on the median line, on the distal fourth, except the present one. The size of the ramus resembles that of the *Cetotherium palæatlanticum* of Leidy, and represents a species of about twenty-five feet in length.

TRETULIAS BUCCATUS, gen. et sp. nov. Plate vi, Fig. 2.

Char. gen.—Dental canal obliterated, and dental groove without osseous roof. Gingival canals and foramina present at one side of the alveolar groove.

The presence of the gingival canals and foramina in this genus, and their absence in *Ulias*, suggests two alternative phylogenies. First, it is possible that *Tretulias* is derived from *Siphonocetus* by failure of the roof of the gingival groove to develop external to the gingival canals by re-

tardation. Or, second, it may have been derived from *Ulias* or its ancestor, by development of the roof about the gingival canals only, leaving the remainder of the groove open. In the latter case it represents a stage intermediate between *Ulias* and *Cetotherium*. But one species is known to me.

Char. specif.—This species is represented by parts of the mandibular rami of two individuals, both preserved in the Museum of Johns Hopkins University of Baltimore. One of these measures 607 mm. in length, and is in fairly good preservation; the other is a shorter fragment, and is considerably worn. They agree in all respects.

The longer fragment is gently curved both inwards and downwards. It is compressed anteriorly, and more depressed posteriorly, so as to be but little deeper than wide. The external face is very convex, more so posteriorly than anteriorly, so that that part of the superior wall which is developed is horizontal, as in the *Siphonocetus priscus* Leidy. The internal face is little convex, and is slightly concave on a line near to and parallel to the inferior border. Generally this angle is obtuse, and is a little more than right; anteriorly, near the extremity it becomes more ridge-like. Posteriorly the section of the ramus represents more than a half-circle, the base being the internal face. The internal basal concavity referred to disappears posteriorly, but its place is occupied by a Meckelian fissure, which extends along the bottom of the groove, disappearing at the end of the terminal two-fifths of the length.

The gingival canals are very oblique, extending horizontally forwards and outwards. The internal foramina issue at spaces of one and two inches, and they are not connected by a superficial groove. The superior (external) series are equally oblique, extending forwards and opening obliquely upwards. Only two of these canals are present on the specimen, and these are on the posterior two-fifths of the length. They are not complete on the external side, and are therefore only grooves. The common canal is open external to them, and separates the superior from the external face of the ramus. It has not the form of the section of the ramus as in other species, but is shallow, and with its long axis oblique to that of the section, and parallel to that of the superior oblique part of the external face. It is shallower than in the *Ulias moratus*, and the species of *Cetotherium*, and is separated by a wide osseous space from the inferior border. That this form is descended from one with a larger canal is indicated by the fact that the fractures of the ramus display a closed fissure extending from the floor of the canal vertically downwards. The canal is overhung on the inner side by a narrow free border of the superior perforate wall.

Measurements.

	M.
Length of fragment.....	.607
Diameters posteriorly { vertical .....	.077
{ transverse.....	.078

<i>Measurements.</i>		M.
Diameters more anteriorly	vertical .....	.070
	transverse.....	.065
Diameters near distal extremity	vertical .....	.073
	transverse .....	.056

For a length of 200 mm. from the anterior extremity the borders of the gingivodental groove are sufficiently well preserved to demonstrate that it was not closed. The edges posterior to this are more or less worn, so that the roof might be supposed to have been broken away in the absence of other evidence. This is, however, forthcoming, for the internal border is so far preserved near the posterior extremity for a space of 135 mm. as to show that no roof has existed.

Omitting consideration of the generic characters, the following comparisons with other species may be made. In the *Ulias moratus* the gingivodental groove is deeper and narrower, and the inner edge is much narrower. The external face is not so convex. The *Siphonocetus priscus* of Leidy resembles it more nearly in form, but the superior (external) foramina are not so far inwards, and the two canals taken together conform nearly to the outline of the ramus in section, which is far from being the case in the *Tretulias buccatus*. There is no Meckelian groove. In the *Cetotherium palæatlanticum* Leidy, the external face is not so convex, and the internal gingival canals are, according to Leidy, "directed upward and moderately forward." In the *T. buccatus* they are directed forwards horizontally, and very little upwards.

Dr. Leidy has regarded the presence of a Meckelian fissure on the ramus of *C. palæatlanticum* as a specific character, and possibly as generic, as he has given a new generic name to it,* without diagnosis. This fissure I have not observed in any of the rami described by me, except in the case of the present species. It is figured by Van Beneden in some of the Balænidæ of Antwerp, and is stated by him to be common to all the Balænidæ. It is, however, not visible in many recent skeletons, and I am inclined to doubt whether it is normal in adult animals. When the rami of recent Balænidæ dry, they sometimes split along the line of the primitive Meckelian groove, but not always. It remains to be seen whether this is the origin of the fissure in the present species and in the jaw described by Prof. Leidy. The generic name proposed by Prof. Leidy (*Protobalæna*) is preoccupied by Van Beneden (1867).

CETOTHERIUM PUSILLUM Cope, *Amer. Naturalist*, 1890, p. 616.

Eschrichtius pusillus Cope, *Proceeds. Acad. Nat. Sci.*, Phila., 1868, p. 191; 1869, p. 11.

The fragment of the ramus of this species above referred to is longer than any that have come under my observation, which now number five individuals. Its length is 723 mm., and the diameters at a fracture near

* *Extinct Mamm. Dakota and Nebraska*, 1869, p. 440.

the middle are as follows: vertical, 71 mm.; transverse, 47 mm. It is a little larger than those I have seen hitherto, but agrees with them in every respect. Plate vi, Fig. 6.

CETOTHERIUM MEGALOPHYSUM, sp. nov.

This species is established on a cranium which is complete from the condyles to near the anterior extremity of the nasal bones inclusive. The apices of the zygomatic processes of the squamosal bones and the left auricular bulla are wanting. The presence of the right bulla in the specimen enables comparisons to be made with species in which this part is preserved and where the cranium is wanting. The skull has lain in the water for a considerable time, as numerous barnacles and oysters have attached themselves to it. The matrix has been generally removed from it by the action of the water.

The cranium presents the characters of the genus in the close approximation of the temporal fossæ on the middle line and the elongation of the frontals anterior to this point. Portions of premaxillaries and maxillaries remain at positions much posterior to that of the external nares. The glenoid surface is separated by a sharp angle from the temporal fossa. The sphenoid and presphenoid are keeled on the median line. The vomer is visible between the palatines on the middle line below.

The lateral occipital crests form with a line connecting the exoccipital processes across the foramen magnum, an isosceles triangle with straight sides, each of which is rather shorter than the base-line mentioned. The apex of the supraoccipital is not elevated, and is well produced forwards, so that the length of the cranium from the posterior border of the frontal bone is one and one-half times as long as the depth of the cranium at the same point.

The tympanic bulla has the general form characteristic of species of this genus, but presents specific characters of its own. The part anterior to the posterior boundary of the external process is half as long again as the length posterior to it. The two measurements are equal in the *C. hupschii*, according to Van Beneden. The two ridges of the internal border unite 19 mm. posterior to the anterior extremity, forming a single acute angle. This character is not described by authors as occurring in any other species of this genus. The anterior extremity is squarely truncate, and is semicircular in outline, as the superior side is flat and the inferior convex. In *C. brialmontii*, according to Van Beneden, the bulla is not truncate in front nor is there a single acute edge on the inner side in front; the portions of the bulla anterior and posterior to the internal process are of equal transverse width; in the *C. megalophysum* the anterior portion is considerably narrower than the posterior portion. In *Mesocetus agramii*, according to Van Beneden, there is a single acute internal ridge on the bulla, but it is much longer than in the *Cetotherium megalophysum* and the anterior extremity of the bulla is rounded and not truncate in the former. The bulla in the species now described presents an

angle posteriorly, as viewed from below, instead of the rounded outline seen in several species.

The form of the skull differs from that of several species where that region is known. Thus in the *C. burtinii*, according to Van Beneden, the occipital bone is broadly rounded in outline instead of triangular. In *C. dubium* this region is triangular, but is much more elevated and less produced forwards than in the *C. megalophysum*. It is more elevated than the length from the frontal bone posteriorly, instead of being only two-thirds as high as long. In the *C. morenii*, from Chubut, Patagonia, Lydekker states that the lateral occipital crests are more elevated than the apex of the occipital bone, giving a cordate outline to the posterior profile. This does not occur in any known northern species. The tympanic bulla of this species is also quite different. The occipital region of the *C. hupschii* resembles that of the *C. megalophysum* more nearly than that of any other species as far as known. In the *C. capellini* Van Ben., according to the descriptions and figures of Capellini, the frontal is more elongate and narrower on the middle line and the tympanic bulla has not the posterior median angle when viewed from below such as exists in the *C. megalophysum*.

Comparison with the species described by Brandt from Russia and Italy, discloses numerous important differences.* The frontoparietal region in the *C. priscum* Br. is materially shorter than in the *megalophysum*. The auricular bullæ of *C. priscum*, *C. meyerii* and *C. klinderii* are gradually acuminate to an acute apex, when viewed from the inner side, and are without the convexity of the lower side and the truncation of the apex characteristic of our species. The bulla of the *C. rathkei* is a little more like that of the Chesapeake form, but it is nevertheless specifically distinct. It is, when viewed from above, broadly and subequally rounded at both extremities, instead of being truncate at the one and angulate at the other. The extremities are of subequal width, while the anterior portion is much narrower in the *C. megalophysum*.

Finally, the bulla of the *C. megalophysum* is of relatively larger size than in any of the species noticed above.

Measurements.

	M.
Length of fragment below . . . . .	.565
Width of fragment . . . . .	.515
Width of glenoid region from bulla . . . . .	.150
Length of glenoid region from bulla (least) . . . . .	.100
Width of sphenoid between foramina lacera . . . . .	.105
Length of tympanic bulla below . . . . .	.100
Width of tympanic bulla in front of external process . . . . .	.53
Width of tympanic bulla behind external process . . . . .	.67
Width at exoccipital processes . . . . .	.400

* *Memoires Acad. Imp. Sciences*, St. Petersburg, 1873, xx, p. 143.

<i>Measurements.</i>	M.
Length anterior to parietals above.....	.225
Length of occipital from base of foramen magnum to apex (on curve) .....	.290
Width of occipital condyles and foramen.....	.140

The mandible of this species is unknown. The size is not far from that of the *Cetotherium pusillum* and *Siphonocetus expansus* of Cope. Should either of these turn out, on the discovery of the skull, to be Cetotheriform, it will become necessary to compare them with the present species. The total length of the animal was about twenty or twenty-five feet.

CETOTHERIUM CRASSANGULUM, sp. nov.

This species is represented by an imperfect skull, to which adhere three cervical vertebræ, the posterior parts of both mandibular rami, parts of the hyoid arch and a humerus. The sagittal part of the skull is crushed and the frontal bones somewhat displaced outwards. Large portions of the nasal bones remain, but the premaxillaries and maxillaries are mostly wanting. By excavating at the proper point the right otic bulla was brought to light. The presence of this structure, together with a considerable part of the mandibular rami, enables me to compare the individual with known species and to determine its specific reference with certainty. The coössification of all the epiphyses shows that the animal is adult.

The species belongs to that group in the genus *Cetotherium* which is characterized by the presence of a developed angle of the mandible, but where it is short and broadly truncate. The angle is, however, scarcely separated from the condyle, and partakes of the articular surface, apparently much as in the *Balenoptera emarginata* of Owen. It is further distinguished from such species as *C. priscum*, *C. meyerii* and *C. klinderii* by the oval and little-compressed form of the otic bulla, resembling in this part rather the *C. rathkei*. From the *C. megalophysum* the bulla differs by the much smaller dimensions as well as the different form. Thus while the exoccipital width of the skull of the *C. crassangulum* is half as great again as that of the *C. megalophysum*, the length of the bulla is only about three-quarters that of the latter. The bulla of the *C. cephalus* Cope is very different in form from that of either species. It is of the compressed type and is a little smaller than that of the *C. crassangulum*. It is truncate both anteriorly and posteriorly, which is not the case with that of the latter species.

Although the sagittal crest is crushed away, it is evident that it is much less elevated relatively to the width of the skull than in any of the species so far known. This elevation, allowing for the injury, was about equal to that in the *C. megalophysum*, measured from the floor of the foramen magnum. The exoccipital width is one-half greater than that of the latter species. The narial orifice was about as far in advance of the supraoccipital angle as in the *C. megalophysum* and much further than in any existing whale. The supraorbital portions of the frontal are wanting

and the nasals are spread apart laterally in the matrix. Their lateral portions are produced forwards on each side of the nares for a considerable distance, as vertical plates, in a manner which I have not observed in any other Balænid. The proximal extremity of the bone has the vertical laminate suture usual in the family. The bulla is oval and, viewed from below, the extremities are regularly rounded, the posterior but little wider than the anterior. The inferior side is regularly convex in all directions and the interior edge is flattened as in various other species of Cetotherium. The two lateral internal longitudinal angles come together well externally on the anterior end, thus leaving a very short anterior keeled edge. The fate of the angles is not visible posteriorly, as the bulla is in place, but they do not seem to come together.

There is preserved of the right mandibular ramus .595 m. from the angle forwards, and a corresponding part of the left ramus, measuring .740 m. The condyles and angles of both sides are preserved. The condyle is compressed, and the articular face presents both upwards and backwards. The angle is broadly truncate, its outline a broad parallelogram, which, when placed vertically, presents its lateral upper angle to the condyle, which obliquely truncates the same. The two surfaces are separated by a shallow groove for only a part of this contact; elsewhere they are continuous. The presence of a coronoid process cannot be positively demonstrated, owing to the position of the rami in the matrix. The ramus of the left side displays its characters at the anterior extremity of the fragment. The convexity of the external face, as usual, exceeds that of the internal, but both are rather flat and meet above at an angle which is a little less than a right angle. Foramina are very few in the portion of the ramus preserved. There is a very shallow groove on the internal side of the superior angle, which is pierced by a single small foramen. On the external side a single foramen of still smaller size pierces the external wall anterior to the position of the internal foramen mentioned, and three times as far below the superior angle. The inferior edge of the left ramus is preserved at a position not far posterior to that just described of the right ramus. It presents an obtuse angle, indicating that a more acute angle exists anterior to its position. Posteriorly the right ramus is rounded more broadly below.

The characters of the ramus differ from those of any of the North American species so far known. In *S. clarkianus* and *C. polyporum* the foramina are much more numerous at the corresponding locality. The form of the part is different in the *S. expansus*, *C. pusillum* and *C. cephalus*. In *C. polyporum* and *C. cephalus* the form is more compressed and the superior edge more acute; in the other species named it is less so. There is no meckelian groove as in the *C. paleatlanticum*.

The three cervical vertebræ diminish in anteroposterior and transverse diameters from the first to the third. The diapophyses of the atlas arise opposite to the base of the neural canal and are short. The distal end of each is depressed. No tuberculum atlantis. The axis is slightly concave

transversely below between the bases of the parapophyses. The latter are directed obliquely backwards at an angle of 45° from the articular surface and are vertically expanded at the distal extremity. The parapophyses of the third cervical are as long as those of the second, but are more slender.

The humerus is of the size of that of the *Cetotherium brialmontii*, as represented by Van Beneden, and has the moderately elongate form characteristic of the species of *Cetotherium* so far as they are known. The tuberosity and crest are broken off, but a portion of the smooth surface which connects the former with the head remains. The distal end is somewhat crushed and the olecranon facet is not as well distinguished from the remainder of the ulnar facet as in most specimens. The humerus is distinguished by two peculiarities. The crest ceases near the middle of the length, and there is a wide and medially deep fossa on the inner side of the shaft immediately beyond the line of the distal end of the crest. Van Beneden figures a somewhat similar fossa in the *Cetotherium lupschii* Van B., but in that species its position is more proximal and it is bounded anteriorly by the distal portion of the crest. The other species of *Cetotherium*, and those of *Balenoptera* figured by Van Beneden, do not present this fossa.

Measurements.

	M.
Total length of fragment from line of paroccipital . . . . .	.870
Axial length from occipital condyles to nasal bones, inclusive . . . . .	.660
Length on occipital bone from foramen magnum to apex of supraoccipital, inclusive (apex restored) . . . . .	.300
Width of skull at paroccipital processes . . . . .	.820
Width of skull at exoccipital processes . . . . .	.620
Width of condyles and foramen . . . . .	.215
Width of foramen magnum . . . . .	.070
Length of mandibular ramus to posterior foramen . . . . .	.680
Depth of condyle and angle posteriorly . . . . .	.165
Depth of posterior face of angle . . . . .	.120
Width of posterior face of angle . . . . .	.090
Vertical diameter of condyle (axial) . . . . .	.078
Transverse diameter of condyle (axial) . . . . .	.070
Depth of ramus at last foramen (approximate) . . . . .	.140
Depth of ramus 130 mm. anterior to condyle . . . . .	.110
Diameters of otic bulla { anteroposterior . . . . .	.080
{ transverse { at notch . . . . .	.048
{ at process . . . . .	.055
Length of epihyal . . . . .	.120
Diameters of atlas { anteroposterior below . . . . .	.060
{ transverse { of centrum . . . . .	.224
{ do. with diapophyses . . . . .	.328
Diameters of axis { anteroposterior below . . . . .	.040
{ transverse in front . . . . .	.172

sursiplana, although it is not so sharply defined by a strong transverse convexity of the superior surface, as in the latter. Nor is there as strong a bevel of the anterior extremity of the superior face when viewed from within, as in *B. definita*. An equally conspicuous difference is to be seen in the form of the inferior wall. According to Lydekker this surface, when the bulla is viewed from within, consists of three planes separated by rounded angles, of which the median is longer than those at the ends. In the *B. sursiplana* this surface is regularly convex from end to end. In size this species is like that of the large Balænoptereæ, including the *B. definita*.

<i>Measurements.</i>	MM.
Axial length of bulla.....	98
Width at posterior extremity of anterior hook at superior border.....	71
Width at anterior extremity of orifice.....	35
Width at posterior extremity of orifice.....	53
Depth at middle (about).....	55
Greatest depth of lip.....	38

BALÆNA AFFINIS OWEN, *Brit. Foss. Mamm. and Birds*, 1846; plate opp. p. xlv. Lydekker, *Catal. Foss. Mamm. Brit. Mus.*, v, p. 17, Fig. 7.

Two otic bullæ agree with the figures and descriptions of this species, except in their smaller dimensions. The smallest given by Lydekker is 120 mm. The larger specimen in the Johns Hopkins collection is 105 mm., and the smaller is 95 mm.

All of the material described in this paper, excepting the type specimen of the *Cetotherium crassangulum*, belongs to the Museum of the Johns Hopkins University of Baltimore; and I wish to express my obligations to the authorities of that institution, and especially to Prof. William B. Clark, in charge of the Department of Geology, for the opportunity of studying it.

EXPLANATION OF PLATE.

Diagrammatic sections of the left mandibular rami of species of Balæni-dæ, one-half natural size.

- Fig. 1. *Ulias moratus* Cope.
- Fig. 2. *Tretulias buccatus* Cope.
- Fig. 3. *Siphonocetus priscus* Leidy.
- Fig. 4. *Siphonocetus clarkianus* Cope.
- Fig. 5. *Siphonocetus expansus* Cope.
- Fig. 6. *Cetotherium pusillum* Cope.
- Fig. 7. *Cetotherium polyporum* Cope.

Lettering: *E. G.*, External gingival canal; *I. G.*, Internal gingival canal; *G. G.*, Gingival groove; *D. C.*, Dental canal.

APPENDIX.

MESOCETUS SIPHUNCULUS, sp. nov.

The genus *Mesocetus* was established by Van Beneden* for *Mystacoceti* in which the posterior part of the mandibular ramus approaches in its characters that of the *Odontoceti*. That is, the condyle is situated at the middle of the vertically compressed posterior border, and is more or less expanded transversely. It is thus below the superior part of the posterior extremity of the ramus, instead of constituting that part, as it does in the whalebone whales generally. That structure is naturally adapted to a more anterior direction of the glenoid cavity, as is shown by Van Beneden. The only known species of the genus is the *M. agrami* Van Ben. from the Neocene beds of Agram in Croatia, Austria. It is of much interest that a second species is now determined to have existed in the Neocene formation of Virginia.

Van Beneden does not appear to have seen much if any of the mandibular ramus anterior to the condyle. I have a ramus nearly entire, and smaller parts of three others, and can thus locate the genus *Mesocetus* in relation to those already defined. In the species now to be described, the ramus has no large dental canal, but it is almost entirely filled with spongy bone of moderate coarseness. The gingival canals unite into a single tube which is not larger than one of the external gingival canals, and which runs about opposite to them or a little distance below the superior edge. In this disposition of the canals *Mesocetus* differs from any of the genera of *Mystacoceti* referred to in the preceding pages.

Char. specif.—Founded primarily on a nearly complete right mandibular ramus, and represented by the anterior part of a second ramus of a smaller individual. The distal part of the ramus of a third individual resembles the last one, but differs in some respects from it, so that the reference cannot now be made. These specimens I saw taken from the same locality and bed, and I took the type specimen myself piecemeal from the deposit. The latter is a wet phosphatic marl, and it was impossible to remove the specimen without damage. It has been reconstructed under my eye by my assistant so as to be in good condition.

The ramus exhibits little curvature in any direction. It is strongly compressed, and although the external face is more convex than the internal, the convexity is not great. The superior border is throughout thicker transversely than the inferior. Both are obtusely rounded anteriorly, but both become more compressed posteriorly. The inferior border becomes rather acute posteriorly. The usual ledge is present on the internal or symphyseal side of the distal extremity. The representative of the anterior part of the dental canal issues posterior to the distal border and a little below the superior border; the external border of the

* *Memoires de l'Academie royale des Sciences de Lettres et des Beaux Arts de Belgique* 1882, Vol. xlv.

foramen is notched, and a shallow groove rises from its superior angle and returns posteriorly as a shallow groove of the superior middle line. This groove disappears in a small median foramen, the first of the series of small foramina of the inner side of the superior border. The foramina of this series are small and represent the exits of narrow canals which run horizontally inwards so close together that a fractured surface passing through them resembles a sutural surface with oblique grooves. From a median superior position they assume an internal lateral position, and disappear at about the posterior third of the ramus. The inner face of the ramus above these foramina becomes slightly concave. The large external foramina are rather numerous and are situated at intervals of about 45 mm. They are situated posteriorly about as far below the superior edge as those of the internal series, and they retain that position anteriorly, not rising to a higher position, as is the case with those of the internal series. Posteriorly the internal face becomes slightly concave next the inferior border. The posterior part of the ramus is strongly concave on the inner side, and is thin walled. The base of the coronoid process indicates that it is flared outwards.

The condyle is a vertical oval tapering more gradually upwards than downwards. The superior border of the ramus is thin and curves strongly inwards, quite as Van Beneden has restored the corresponding part in the *M. agrami*. This condyle differs from that of the *M. agrami* in having a less transverse extent, especially on the inner side, and in lacking the transverse ridges and grooves described and figured by Van Beneden (Pl. ii, Fig. 10). This is the only part of the two animals which is present in both specimens; and the comparison indicates that the species are different.

I have probable vertebræ of this species, but I cannot yet associate them with certainty. A first dorsal was found in immediate contact with the posterior part of the ramus. This resembles considerably the corresponding vertebra of the *M. agrami* described by Van Beneden. It has lost its epiphyses, but if these were added, its anteroposterior diameter would be less than that of the latter, and there is not nearly so conspicuous a facet for the head of the first rib. This is very indistinct in my vertebra. A perfect humerus was also found near the position from which the second and third rami were dug out. Until I know the proper relation of this humerus I will only describe it so far as to say that it has the proportions of that of *Cetotherium*, but that the tuberosity is not produced beyond the head, and the olecranal facet is not distinguished by an angle from the remainder of the ulnar facet.

<i>Measurements.</i>		MM.
Total length (subject to some correction on account of a fracture).....		1290
Diameters at mental foramen	{ vertical.....	97
	{ transverse.....	28
Diameters at 500 mm. from distal end	{ vertical.....	90
	{ transverse.....	48
Diameters of condyle	{ vertical.....	120
	{ transverse.....	61
Diameters of centrum first dorsal vert.	{ vertical.....	57
	{ transverse.....	85
	{ anteroposterior.....	31
Expanse of diapophyses.....		170

From the Miocene marl of the Pamunkey river, Virginia.

Stated Meeting, March 1, 1895.

Treasurer, Mr. PRICE, in the Chair.

Present, 15 members.

Dr. Richard A. Cleemann, a lately-elected member, was presented to the Chair.

Correspondence was submitted as follows:

Letters accepting membership from Dr. Richard A. Cleemann, Philadelphia; Mr. Richard S. Hunter, Philadelphia.

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